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Curriculum Guide

for

MATHEMATICS 31

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Acknowledgement

The Department of Education acknowledges with appreciation the contributions of the members of the Senior High School Mathematics Policy Committee and those of the Ad Hoc Subcommittee to the preparation of this Curriculum Guide for Mathematics 31.

Although committee membership has changed substantially since the 1968 edition of this guide was published, this edition differs primarily as a result of deletions from the original. For this reason, acknowledgement is appropriately given to those who did the original preparation.

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NOTE:

This curriculum guide is a service publication only. The information is prescriptive only insofar as the content of the curriculum guide duplicates that contained in the Senior High School Program of Studies. The curriculum guide contains as well as content, methods of developing the concepts, suggestions for use of teaching aids, and lists of additional reference books.

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OBJECTIVES OF THE
SENIOR HIGH
MATHEMATICS PROGRAM

While the academic, vocational, and commercial sequences of courses have different specific objectives the common general purposes of Senior High School Mathematics courses are as follows:

1. To develop an understanding of mathematics as a creation of man and to develop an appreciation of the contribution of this discipline to the progress of civilization.

2. To develop precision in thought and expression.

3. To develop and maintain an understanding of the operations and concepts of mathematics.

4. To develop and maintain skill in mathematical operations.

5. To develop powers of logical analysis of problems and to present their solution in a clear and precise manner.

MATHEMATICS 31

OBJECTIVES OF MATHEMATICS 31

The general objectives of high school mathematics programs stated above apply to Mathematics 31. Following is a statement of the more specific objectives of the course:

1. To develop an understanding of the properties of functions and their role in many different areas of mathematics.
2. To prepare the student for further courses in calculus, vector analysis and matrix theory.
3. To develop manipulative skills.
4. To help the student to appreciate the need for precision of language.
5. To assist the students to see that mathematics is a subject of humanistic value and that it is an integral part of our culture.
6. To help the student to appreciate that mathematics is a living and growing discipline.

Mathematics 31 is made up of two parts:

1. Calculus, and
2. Vectors and Matrices

1. Elliott, H. A., K. D. Fryer, J. C. Gardner, and N. J. Hill. *Calculus*. Toronto: Holt, Rinehart, and Winston of Canada, Limited, 1966

2. EITHER
Elliott, H. A., K. D. Fryer, J. C. Gardner, and N. J. Hill. *Vectors and Matrices*. Toronto: Holt, Rinehart, and Winston of Canada Limited, 1967.
OR
Elliott, H. A., et al. *Vectors, Matrices and Algebraic Structures*. Toronto: Holt, Rinehart, and Winston of Canada, Limited, 1973.*
(This edition has many errors and has been replaced by a 1974 reprint -- same title, authors and publisher -- blue cover)

*See Note page 7

COURSE OUTLINE FOR CALCULUS

Texts:

EITHER
Elliott, H. A., D. Fryer, J. C. Gardner, and N. J. Hill.
Calculus. Toronto: Holt, Rinehart, and Winston of Canada, Limited, 1966.
OR
Elliott, et al. *Calculus, Complex Numbers and Polar Coordinates*.
Toronto: Holt, Rinehart, and Winston, 1974. (See note below).

Teacher References:

Elliott, et al. *Solutions for Calculus*.

Lang, S. *Calculus*. Don Mills: Addison-Wesley

CONTENT:	SUGGESTED NO. OF 40 MIN. PERIODS
Chapter 1: Slopes and Tangents	10
Chapter 2: Distance, Velocity and Acceleration	9
Chapter 3: Maxima and Minima	7
Chapter 4: Sequences, Limits and Derivatives	10
Chapter 5: Derivatives of Functions	8
Chapter 6: Tangents, Derivatives, and Graphs	10
Chapter 7: Further Applications of Derivatives	8
Chapter 8: Solutions of $D_x y = f(x)$	9
Chapter 9: Areas	9
Chapters 10 and 11: Omit	--
TOTAL	80

NOTE: The text *Calculus* by Elliott et al, 1966 edition is now out of print and not available. It is being replaced by Elliott et al, *Calculus, Complex Numbers and Polar Coordinates*, Holt, Rinehart, and Winston of Canada, Toronto; 1974. The content of Chapters 1 - 8 (incl.) of both the 1966 and 1974 editions is identical. The content of Chapter 9 of the 1966 edition is included as Sections 8.4, 8.5, and 9.4 in the 1974 edition. Chapters 10 and 11 of the edition were omitted as are Chapters 9 (except section 9.4) -- 13 inclusive of the 1974 edition.

SUGGESTIONS FOR TEACHING CALCULUS

NOTE: Omit all supplementary sections and related problems.

Chapter 1 Slopes and Tangents

The main topics are:

The slope of a line
The tangent to a curve
The slopes of tangents to the curve $y = x^2$
The derivative of the quadratic, cubic, and reciprocal functions

This chapter introduces the differentiation of 1, x, x^2, x^3, and x^{-1} by an intuitive study of tangents to graphs. Although the derivatives of these functions are developed, the more general case $D_x y = nx^{n-1}$ is not mentioned until later. Teachers should acquaint the students with all the derivative notations, i.e. $D_x y$, y', $f'(x)$, $\frac{dy}{dx}$.

Chapter 2 Distance, Velocity and Acceleration

The main topics are:

Average and instantaneous velocity
Velocity as a derivative
Acceleration
Stationary points
Maximum and minimum distances and velocities

The idea of velocity as a derivative is developed in this chapter by a careful study of a series of experiments where students are required to estimate the instantaneous velocity at a given time. Here we have the scientific application to the theory developed in Chapter 1.

Chapter 3 Maxima and Minima

The main topics are:

Zeros of the first derivative
Maxima and minima

The only new material in this chapter is that $D_x y = 0$ at a maximum or minimum value of $y = f(x)$. However the chapter contains many excellent problems on maxima and minima. Some time should be spent on the solution of these problems.

Chapter 4 Sequences, Limits and Derivatives

The main topics are:

- Sequences
- Algebraic functions
- Limits
- Theorems about limits and derivatives

Some students will be familiar with sequences and series if they are taking Mathematics 30 so time spent on this section will depend on the class. The concept of an infinite geometric series will be new to every student. Although the limit theorems are not proven, the corresponding theorems for derivatives are proven rigorously. The first two derivative theorems have been used without proof in the first two chapters.

Chapter 5 Derivative of Functions

The main topics are:

- The derivative on x^n
- The chain rule
- The derivative of a product and a quotient

In this chapter the chain rule for derivatives and the derivative of a product and quotient are formally developed. Some students may prefer to change a quotient to a product and use the product formula. In the exercises at the end of the chapter many questions are computationally long and difficult and should be avoided.

Chapter 6 Tangents, Derivatives and Graphs

The main topics are:

- Derivatives and relations
- Tangents
- Graph sketching

The teacher will have to prepare the students for work in this chapter by teaching graphing of polynomials of degree higher than two and graphing of ellipses and hyperbolas. Students must be able to determine the x and y intercepts and find the domain and range of the relations. In this chapter they learn how to sketch graphs by using the first and second derivatives.

Chapter 7 Further Applications of Derivatives

The main topics are:

Distance, velocity and acceleration
Rate and maxima and minima problems

This chapter deals with practical applications to concepts developed previously.

Chapter 8 Solutions of $D_x y = f(x)$ Chapter 9 Areas

The main topics are:

Primitives
Families of Curves
Acceleration, velocity and distance
Areas

These chapters deal with integration, although that term is not used. The students discover that the general solution of

$$D_x y = x^n \text{ is } y = \frac{x^{n+1}}{n+1} + C.$$

COURSE OUTLINE FOR VECTORS AND MATRICES

Text:

EITHER
Elliott, J. Andrew, et al. *Vectors and Matrices.* Toronto: Holt, Rinehart, and Winston of Canada, Limited, 1967.
OR
Elliott, H. A., et al. *Vectors, Matrices and Algebraic Structures.* Toronto: Holt, Rinehart, and Winston of Canada, Limited, 1972 or 1974 reprint.

Additional References:

Elliott, H. Andrew, et al. *Solutions for Vectors and Matrices.* Toronto: Holt, Rinehart, and Winston of Canada, Limited, 1967.

Davies, Philip J., *The Mathematics of Matrices.* Toronto: Blaisdell Publishing Company, 1965.

CONTENT:		SUGGESTED NO. OF 40 MIN. PERIODS
Chapter 1:	Vectors	15
Chapter 2:	Algebraic Vectors	15
Chapter 3:	Length and Inner Product	15
Chapter 6:	Systems of Linear Equations	20
Chapter 7:	Matrices and Linear Transformations*	15
	TOTAL	80

* Optional

NOTE: Schools using the text, *Vectors, Matrices and Algebraic Structures* (1972 or 1974) will note that this particular chapter is not included in these editions. It is recommended therefore, that all teachers of Mathematics 31 include in the course Chapters 1, 2, 3 and 6 which are the same in all texts. Any time remaining as a result of making Chapter 7 optional may be used to work in appropriate areas of interest.

SUGGESTIONS FOR TEACHING VECTORS AND MATRICES

NOTE: The approach used by the authors of the texts is to provide small amounts of new theory with extensive exercises at the end of each topic. The theory is supplemented rather frequently by sections involving many practical applications of the new concepts. Care must be taken not to rush through the early sections of each chapter. The students must be allowed time to become familiar with the new concepts.

The assigned chapters of this book are of about equal length except Chapter 6 which is somewhat longer. An approximate indication of the time required is given. However, since the text has been so carefully planned it appears to be superfluous to suggest any detailed instructions.

Chapter 1 Vectors Suggested time: Approximately 10 hours total

The concepts of vectors and their algebraic properties are briefly introduced at the beginning of this chapter This is followed by a rather challenging section of practical force and velocity problems involving vector solutions

A brief review of the Cosine Law is recommended, as it is required for many of the vector problems. The chapter is concluded with a return to a theoretical study of scalars and vectors.

Chapter 2 Algebraic Vectors Suggested time: Approximately 10 hours total

Vectors in two and three dimensions are discussed. Care is required in the treatment of triplets of real numbers as being coordinates of points in space. The use of three dimensional models would enable the students to develop a quick and thorough understanding of this section.

Chapter 3 Length and Inner Product Suggested time: Approximately 10 hours tota

Extensive drill and frequent reviews are required as the chapter is studied. The topics of resolution of vectors and work require a thorough understanding of the previous material.

Chapter 6 Systems of Linear Equations Suggested time Approx. 14 hours total

This chapter lacks material as to what matrices are and why they are used. It is recommended that the material on matrices in the text be supplemented by that from other sources. Also, care must be taken not to get too involved in the algebraic solutions of linear systems of equations. The main purpose of the algebraic solutions is to introduce and enhance the matrix method of solution of these problems.

Chapter 7 Matrices and Linear Transformations (Optional) Suggested time: Approx. 10 hours total

Matrices and linear transformations are dealt with in some detail in the 1967 edition of the text. The solution book would be of valuable assistance to the teacher who has not recently taken a course in linear algebra. Please note that this chapter is optional. Teachers may elect to do this chapter if texts or appropriate references are available or other appropriate topics may be substituted.

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